MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

DTC5088 – ANALOG AND DIGITAL COMMUNICATION SYSTEMS

(Diploma of Electronic Engineering)

22 OCTOBER 2019
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **6** pages excluding the cover page and **2** pages for appendices.

2. Answer **ALL** question.

3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 MARKS]

a) Given $s_m(t) = 8\cos(20000\pi t)$, $s_c(t) = 4\cos(100000\pi t)$. Find:

i) the equation of a double sideband with large carrier (DSB-LC).

[2 marks]

ii) upper-side band frequency, f_{usb} *and* lower-side band frequency, f_{lsb}.

[4 marks]

iii) the bandwidth of the modulated signal.

[2 marks]

b) Figure 1 is the waveform of an Amplitude Modulated (AM) signal. Given the maximum amplitude $A_{max\,(p\text{-}t\text{-}p)} = 3$ V and minimum amplitude $A_{min\,(p\text{-}t\text{-}p)} = 1$ V.

i) Find the modulation index, m.

[2 marks]

ii) Determine the behavior of the modulation.

[1 marks]

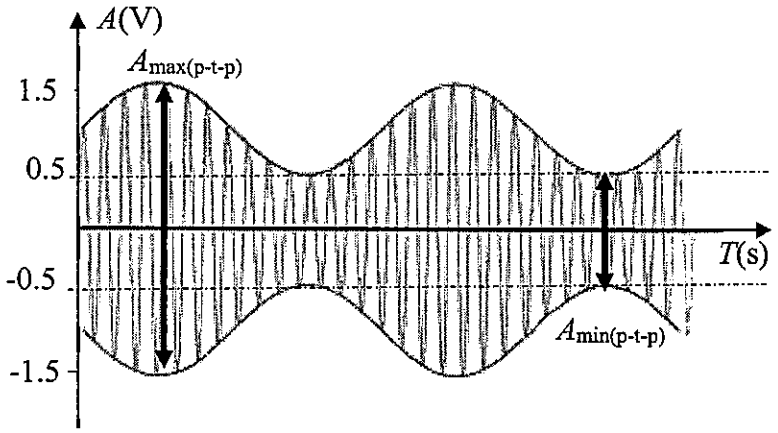

Figure 1

Continued ...

c)

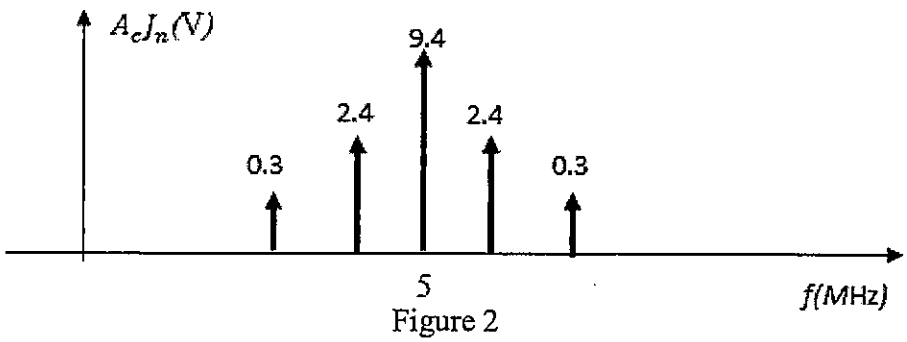

Figure 2

Figure 2 shows the frequency spectrum for a Frequency Modulation (FM) signal. Given to you, A_c=10 and f_m=2 Hz. By using all the data that can be obtained from the diagram, complete Table 1 below:

i) n	ii) J_n	iii) A_cJ_n	iv) $f_{LSB(n)}$	$f_{USB(n)}$
[1.5 mark]	[1.5 mark]	[1.5 mark]	[2.5 marks]	

Table 1

d) Complete the block diagram of a FM stereo in Figure 3 with correct labelling.

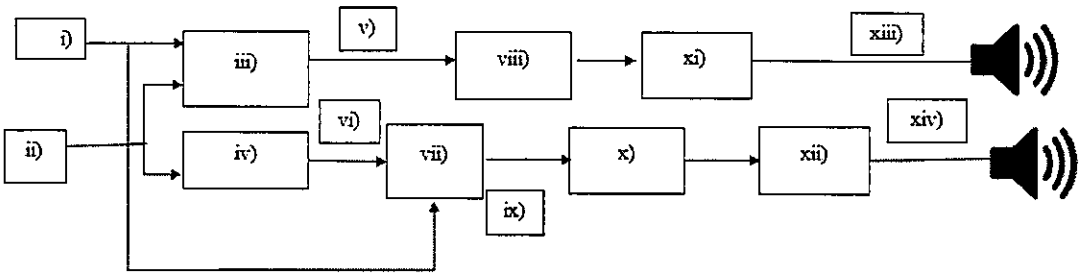

Figure 3

[7 marks]

Continued...

QUESTION 2 [25 MARKS]

a) Explain the two type of Pulse Modulation Systems.

[4 marks]

b) Figure 3 shows the input signal, $g(t)$. Sketch the expected output signal (dotted lines as the sampling intervals) when the input signal is modulated using:

i) Pulse Width Modulation.

ii) Pulse Position Modulation.

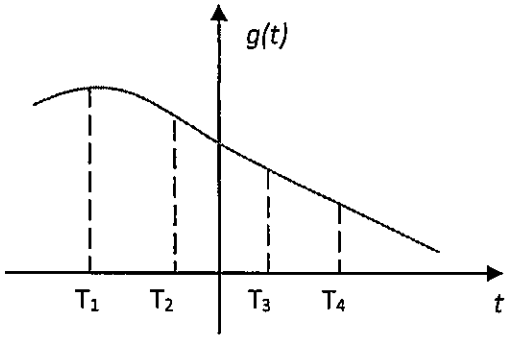

Figure 3

[8 marks]

c) An input signal having maximum frequency of 20 MHz is encoded into Pulse Code Modulation (PCM). The input is sampled at Nyquist Rate and encoded with 16 bit. Determine:

i) Sampling rate.

[2 marks]

ii) Quantization level.

[2 marks]

iii) Bit rate of the PCM signal produced.

[2 marks]

Continued...

d) Figure 4 shows a waveform that is being coded using Pulse Code Modulation. The amplitude level +2 V and -2V are used to represent the binary symbols. The system uses four bits' code-words to represent the data.

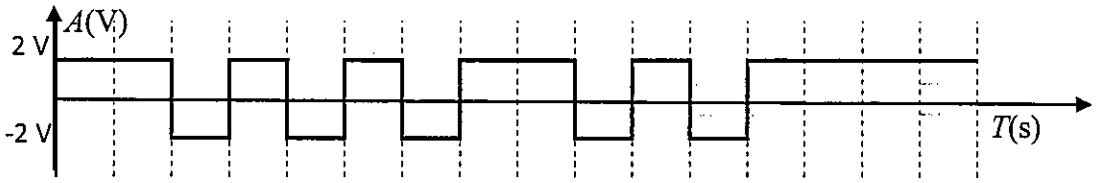

Figure 4

i) Determine the binary code and quantization level used by completing Table 2:

Binary Code	Quantization Level	
a)		[1 mark]
b)		[1 mark]
c)		[1 mark]
d)		[1 mark]

Table 2

ii) Sketch of flat top sample of the original analog data.

[3 marks]

Continued...

QUESTION 3 [25 MARKS]

a) Figure 5 shows a digital data from a digital source. Sketch the expected output, according the following keying schemes:

i) FSK.

[2 marks]

ii) 2-PSK.

[2 marks]

iii) ASK.

[2 marks]

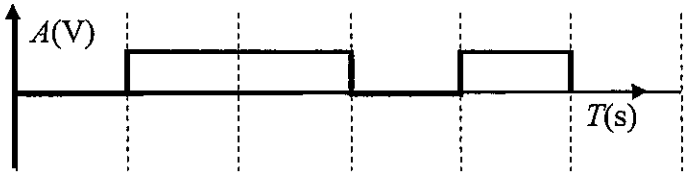

Figure 5

b) An FSK signal is transmitting at 5000 bps. The carriers are separated by 2000 Hz. Find the baud rate and the minimum bandwidth for the signal.

[4 marks]

c) PSK is one of the methods to modulate digital signal back into analog. Provide the phase to bit relationship table and sketch the constellation diagram for 4-PSK.

[4 marks]

d) List three type of digital to digital encoding.

[3 marks]

e) Explain the term Direct Current Component and how this component give problem in data transmission.

[4 marks]

f) Sketch the diagrams that can show the differences between Manchester and Differential Manchester coding using the data of 01001001.

[4 marks]

Continued...

QUESTION 4 [25 MARKS]

a) Define single error and give one example of it.

[3 marks]

b) Explain the concept of redundancy.

[2 marks]

c) Determine the transmitted data for the input of 100100 when generated using the following error checking method:

i) even parity Vertical Redundancy Check (VRC)

[3 marks]

ii) Longitudinal Redundancy Check (LRC).

[3 marks]

iii) Cyclical Redundancy Check (CRC) with divisor of 1101

[6 marks]

d) Show how a system that uses Hamming code detect the position of single bit error, if the receiver received 10101010110 instead of the correct data 00101010110.

[8 marks]

End of Page.

APPENDIX

(A) Amplitude Modulation

Carrier signal, $s_c(t) = A_c \cos(\omega_c t)$

Modulating signal, $s_m(t) = A_m \cos(\omega_m t)$

Amplitude-modulated signal,

DSB-LC: $s(t) = A_c \cos\omega_c t + \frac{A_m}{2}\cos(\omega_c - \omega_m)t + \frac{A_m}{2}\cos(\omega_c + \omega_m)t$

DSB-SC: $s(t) = \frac{A_m A_c}{2}\cos(\omega_c + \omega_m)t + \frac{A_m A_c}{2}\cos(\omega_c - \omega_m)t$

SSB-SC:

$$\text{LSB}: \; s_{LSB}(t) = \frac{A_m A_c}{2}\cos(\omega_c t - \omega_m t)$$

$$\text{USB}: \; s_{USB}(t) = \frac{A_m A_c}{2}\cos(\omega_c t + \omega_m t)$$

(B) Frequency Modulation

$$\begin{aligned}\phi_{FM} = {} & A_c J_0(m_f)\sin\omega_c t + \\ & A_c\left(J_1(m_f)(\sin(\omega_c + \omega_m)t - \sin(\omega_c - \omega_m)t)\right) + \\ & A_c\left(J_2(m_f)(\sin(\omega_c + 2\omega_m)t - \sin(\omega_c - 2\omega_m)t)\right) + \\ & A_c\left(J_3(m_f)(\sin(\omega_c + 3\omega_m)t - \sin(\omega_c - 3\omega_m)t)\right) + \\ & A_c\left(J_4(m_f)(\sin(\omega_c + 4\omega_m)t - \sin(\omega_c - 4\omega_m)t)\right) + \\ & A_c\left(J_5(m_f)(\sin(\omega_c + 5\omega_m)t - \sin(\omega_c - 5\omega_m)t)\right) + \ldots + \\ & A_c\left(J_n(m_f)(\sin(\omega_c + n\omega_m)t - \sin(\omega_c - n\omega_m)t)\right)\end{aligned}$$

(C) AM Superheterodyne Receiver

Local oscillator frequency,

$f_{LO} = f_{RF(C)} + f_{IF(C)}$

$f_{LO} = f_{RF(USF)} + f_{IF(LSF)}$

$f_{LO} = f_{RF(LSF)} + f_{IF(USF)}$

Bessel table function

Modulation Index (m_f)	Carrier Frequency J_0	n or order of sidebands J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}	J_{11}	J_{12}	J_{13}	J_{14}	J_{15}	J_{16}
0.00	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.25	0.98	0.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.5	0.94	0.24	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1.0	0.77	0.44	0.11	0.02	—	—	—	—	—	—	—	—	—	—	—	—	—
1.5	0.51	0.56	0.23	0.06	0.01	—	—	—	—	—	—	—	—	—	—	—	—
2.0	0.22	0.58	0.35	0.13	0.03	—	—	—	—	—	—	—	—	—	—	—	—
2.5	−0.05	0.50	0.45	0.22	0.07	0.02	—	—	—	—	—	—	—	—	—	—	—
3.0	−0.26	0.34	0.49	0.31	0.13	0.04	0.01	—	—	—	—	—	—	—	—	—	—
4.0	−0.40	−0.07	0.36	0.43	0.28	0.13	0.05	0.02	—	—	—	—	—	—	—	—	—
5.0	−0.18	−0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02	—	—	—	—	—	—	—	—
6.0	0.15	−0.28	−0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	—	—	—	—	—	—	—
7.0	0.30	0.00	−0.30	−0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02	—	—	—	—	—	—
8.0	0.17	0.23	−0.11	−0.29	−0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03	—	—	—	—	—
9.0	−0.09	0.24	0.14	−0.18	−0.27	−0.06	0.20	0.33	0.30	0.21	0.12	0.06	0.03	0.01	—	—	—
10.0	−0.25	0.04	0.25	0.06	−0.22	−0.23	−0.01	0.22	0.31	0.29	0.20	0.12	0.06	0.03	0.01	—	—
12.0	0.05	−0.22	−0.08	0.20	0.18	−0.07	−0.24	−0.17	0.05	0.23	0.30	0.27	0.20	0.12	0.07	0.03	0.01
15.0	−0.01	0.21	0.04	−0.19	−0.12	0.13	0.21	0.03	−0.17	−0.22	−0.09	0.10	0.24	0.28	0.25	0.18	0.12

Source: E. Cambi, *Bessel Functions*, Dover Publications, Inc., New York, N.Y., 1948. Courtesy of the publisher.